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Design of Wire and Planar Antenna using AN-SOF

UNITA. P[1], SANTOSH. S[2], LOKESH REDDY. P[3], VENKATESH. M[4], JAIRAJ. P[5]
Dept of ECE, Raghu Institute of Technology, Visakhapatnam, AP, India.

Abstract: Frequency independent antennas are generally used for shortwave radio communications, Telemetry and radio astronomy. Multi-band antennas are used where multiple antennas of different bands are needed. These antennas are used in WLAN as well as wireless applications. The design tool which is used here is AN-SOF. It is an eletromagnetic design and simulation tool which is based on Method Of Moments(MOM), MOM is one of the most validated methods for antenna simulation. AN-SOF uses an improved and advanced form of this method in order to overcome the drawbacks of traditional MOM. According to Method Of Moments, any metallic structure can be modeled using conductive wires and these wires must be divided into small pieces called segments. In this paper, we talk about two types of antennas among which one is wired and the other one is planar. Yagi Uda antenna comes under the former category and dual band microstrip antenna comes under the latter. Both the antennas are multiband antennas. Yagi uda antenna is a high gain antenna and can be operated at HF, UHF and VHF bands.

Keywords: MoM, Yagi Uda Antenna, Dual Band Microstrip Antenna, AN-SOF, Wire Antenna, Planar Antenna.

I. INTRODUCTION

Antenna is an element used for receiving and transmitting signals in any RF system. It is a device used to convert a RF signal on a particular conductor into electromagnetic wave in free space. It maintains the same characteristics while transmitting or receiving and thereby obeys reciprocity[1]. Almost every antenna is a resonant device which operates on a relatively narrow band of frequency. An antenna have be tuned to the same frequency band of a particular system to which it is connected, otherwise the reception and transmission will be impaired making the antenna useless. When a signal is fed into an antenna, the antenna emits radiation distributed in space in a certain way. It can be shown using a graphical representation of the relative distribution of the radiated power in the space and is called as radiation pattern [1]. An antenna acts as a transducer[2]. It also acts as an impedance matching device. It is a radiator and a sensor of electromagnetic waves. It is an essential device or element of all types of communication and radar systems. It can be considered as a source of electromagnetic waves[7]. Antennas are used in many places like houses, cars, trains, ships, spacecrafts, aircrafts, satellites and radars etc[2]. Antennas can be classified into two types. They are:

- Wire antennas
- Planar antennas

A wire antenna is an antenna consisting of a long wire whose wavelength does not depend on its length but the length is chosen for convenience whereas Planar antennas are nothing but the antennas in which all the elements both active and parasitic are in one plane[3]. Various types of wire antennas are short dipole antenna, dipole antenna, monopole antenna and loop antenna. Of all the above, Yagi Uda antenna comes under array of dipole antennas which is very important among the remaining wire antennas even though every antenna has its own significance[9]. In the same way, Various types of planar antennas include patch antenna, slot antenna, ring antenna, spiral antenna, bow-tie antenna, TSA antenna, LPDA, leaky wave and quasi yagi antenna[10]. Of all the above patch antenna is very important and have a great significance which is discussed in the next sections. Further the paper is organized as follows. Brief introduction to AN-SOF is given in section-II. Designing of Yagi Uda antenna along with results is mentioned in section-III. Designing of Dual band microstrip antenna along with corresponding results is mentioned in section-IV. Conclusion is given in section-V. Acknowledgement is provided in section-VI. Section-VII comprises of references used in order to write this article.

II. INTRODUCTION TO AN-SOF

AN-SOF is an antenna modeling software. An antenna model in general is nothing but a representation of a real world antenna in the form of a computer program. It is different from the scale model which is built to measure the radiation characteristics of identical antenna which is actually larger in size. Antenna modeling software is something that simulates the antenna model. It can be used to learn more about antennas, to get better insight into the behavior of antennas, to design better antennas, to predict antenna performance, to try several possibilities before building the real model. AN-SOF is as said before an antenna simulation software which is capable of allowing us to do various operations like describing the geometry of antenna, choosing the construction materials, describing the environment and the

ground conditions, describing the antenna height above the ground, analyzing the radiation pattern and front-to-back ratio, plotting directivity and gain, analyzing the impedance and standing wave ratio and also to predict the bandwidth[4].
AN-SOF is definitely easiest software to use for the simulation of different antenna systems and also the accurate one. Some of the advantages of this software are:

- Fast and easy input and output graphical interfaces.
- Exact description of geometry details is provided.
- It has extended frequency range.
- MATLAB component runtime is provided for higher accuracy and speed.

AN-SOF has the ability to compute the electric currents flowing on metallic structures which includes antennas in transmitting as well as receiving modes and also in scatterers. Scatterers are objects that can either reflect or diffract the radio frequency waves[4]. AN-SOF uses an improved and advanced form of this method in order to overcome the drawbacks of traditional MOM[4]. According to Method Of Moments, any metallic structure can be modeled using conductive wires and these wires must be divided into small pieces called segments. In traditional MoM, the structures which are to be modeled are divided into straight wire segments. These straight wire segments can be of no problem in the case of linear antennas like dipoles. But it will be a problem causing an error for the antennas which are in curved shape. Such drawbacks are overcomed in the next version of MoM which is called "The Conformal Method Of Moments". This is used in AN-SOF for better results.

III. DESIGN OF YAGI UDA ANTENNA

A Yagi Uda antenna or Yagi Uda array generally consists of a driven element, one director and one reflector if it is the case of 3-element yagi uda antenna and this can be simulated using three linear wires[5]. The cartesian coordinates of these wires have to be indicated in meters. The operating frequency have to be set to 3 GHz in the configure tab sheet as shown in Fig.1. Choose Edit/Preferences in the main menu for selecting suitable units for frequencies and lengths. In this case, frequencies will be measured in MHz and length in mm. Then, go to Simulate/Configure... in the main menu. In the Frequency panel of the Configure tab sheet choose Sweep and fill the Frequency Sweep box as shown in Fig.2. Choose Draw/Wire/Line in the main menu. The Draw dialog box for the Line will be shown. Fill the Line and Attributes pages. A straight wire with 17 segments will be drawn. Clicking with the right mouse button on the wire shows a pop-up menu, where the Source/Load command can be selected. By clicking with the right mouse button in any part of a wire a pop-up menu will be as shown in Figs.3 and 4. Choose the Source/Load command from the pop-up menu to display the Source/Load toolbar[4]. Move the Track-bar and select a segment on the wire. Press the Add Source button to display the Add Source dialog box. Choose the type of source and define its amplitude (rms value), phase and internal impedance. Then, press the OK button of the Add Source dialog box. Move the Track-bar, select another segment and repeat steps Press the Exit button of the Source/Load toolbar. put a voltage source in segment number 9, i.e. at the middle point of the wire. The source voltage is 1 (0º) V. The Yagi Uda antenna on the workspace is depicted.

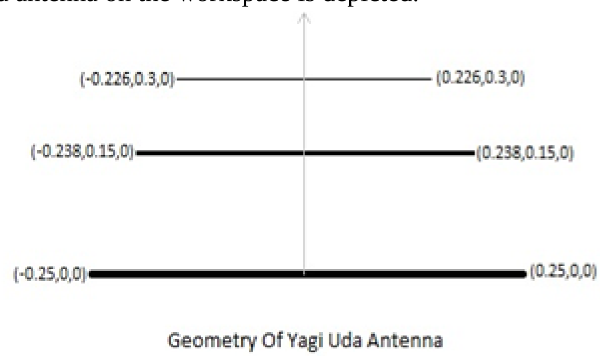

Fig.1. Geometry of Yagi Antenna.

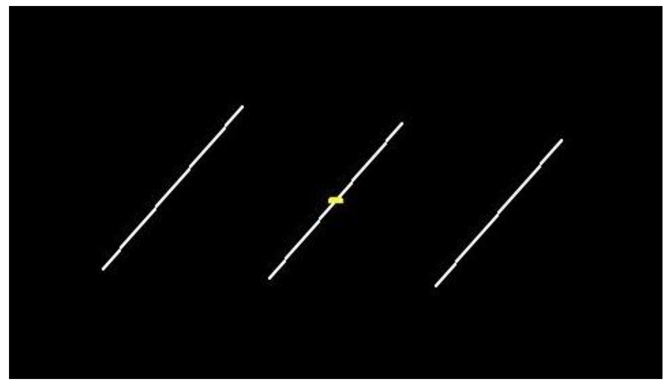

Fig.2. Simulated antenna in AN-SOF.

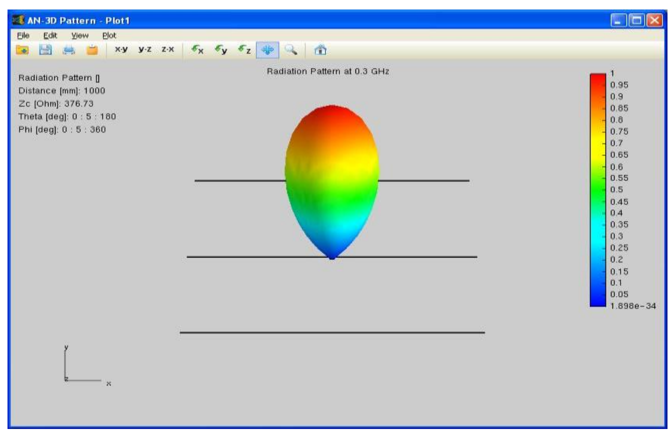

Fig.3. radiation pattern of Yagi antenna.

Press Simulate/Run Currents in the main menu. Once the simulation has finished press Simulate/Run Far-Field. Clicking on the wire with the right mouse button, and selecting Plot Currents in the pop-up menu can show a plot of the current distribution. Then, connect a voltage generator at the middle point of the driven element. Each wire is divided into 15 segments and wire radius is 5 mm. The angular ranges for calculating the far-field are Theta = 0:2.5:180 deg and Phi = 0:5:360 deg. The Power Budget dialog box, where a peak directivity of about 7.8 (or 8.9 dBi) can be obtained. This can also be seen in the directivity pattern of the Yagi-Uda array.

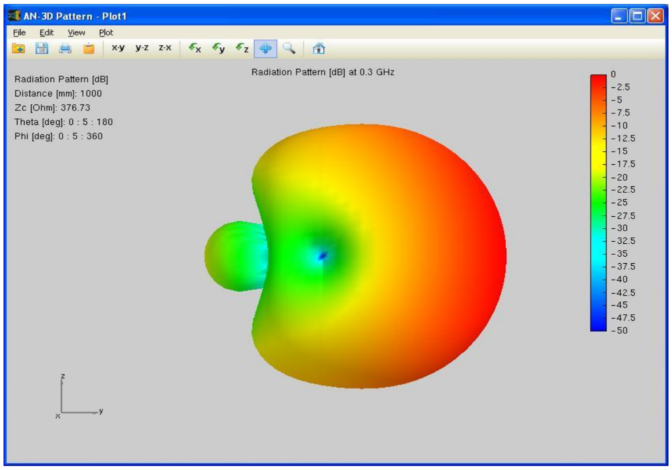

Fig.4. Radiation pattern in dB.

IV. DESIGN OF DUAL BAND MICRO STRIP ANTENNA

A microstrip antenna generally consists of a dielectric substrate on the top and a ground plane on the other side[6]. Go to the toolbar and press the preferences button. Choose a suitable unit for the frequency, length and crossection. Go to the configure tab and define the frequency and for this microstrip antenna keep it to 10GHz.

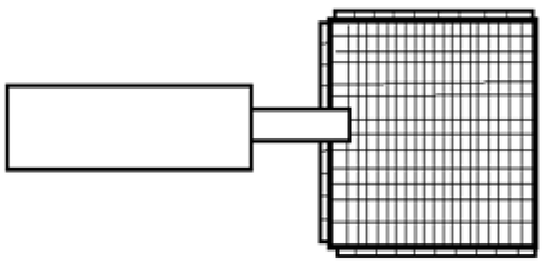

Fig.5. Geometry of dual band microstrip antenna.

Now define the substrate dielectric constant and height. Let the relative permitivity be 2.22 and substrate height as 1.5873mm. Then apply the changes and move to workspace. Press the X-Y plane button in the main tool bar. The microstrip antenna will be placed in this plane as shown in Fig.5. Go to Draw in the main menu and wire grid in the sub menu and then select the patch option. In this panel, give the coordinates of the antenna as (0,-4.4355,0) and (11.939, 4.4355,0). Now move to the attributes tab and fix the number of facets to 11 × 11. The rectangular patch is composed with strips in the workspace. This implies that four currents are flowing on the X and Y directions. Go to the view in the main menu and select the axes option. Select the desired axes for the better visualization. The next step is to connect the quarter wave line to the patch. Right click on the selected strip to connect the line. Now choose the copy end point. Right click on the workspace and select the line option. Press the button 'from point[mm]'. This is the end point that is previously been copied. Write the coordinates for the ending point of the coupling line say X2= -5.3405. Press the attributes tab. Set the number of segments to 5 and change the crossection to line i.e Flat. Set the radius to 1.4232mm. Repeat this procedure for drawing the dipole section for the micro strip antenna. For adding the source(Vs) to the ground plane, right click on the dipole section and click on the end point to ground option. Select the circular crossection for Vs and set the radius to 0.5mm. To feed the structure, a related source is added to the Vs. Right click on the Vs and click on the source/load as shown in Fig.6.

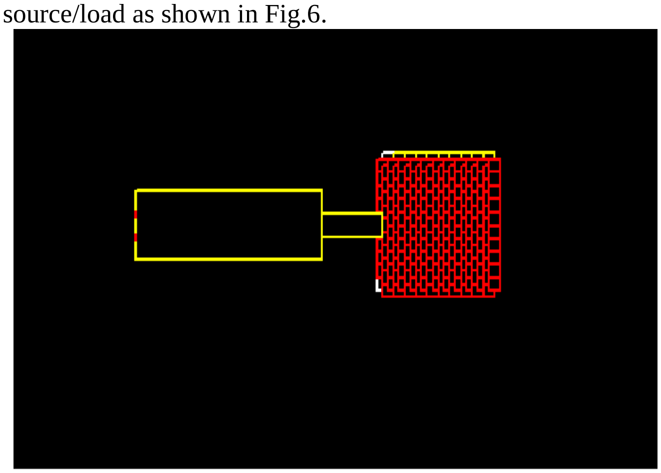

Fig.6. Simulated dual band microstrip antenna.

Press the source button and find the related amplitude and phase. To start the simulation, go to simulation in the main menu and press run currents. Press the current distribution button in the main toolbar to see the colour intensity map of the microstrip antenna as shown in Fig.7. To calculate the far field, go to simulate in the main menu and choose run far field. Press the far field 3D plot button in the main tool bar to plot the 3D radiation pattern. Various patterns and plots can be observed by pressing the plot button in the main toolbar. The magnetic fields near the antenna indicates the zones of maxima and minima of the current distribution[8]. To calculate the near magnetic field, go to the configure tab and set the evaluation points for the field. Go to simulate in the main menu and select run near H- field. To see the magnetic field distribution, go to results in the main menu and select plot near H-field pattern in the 3D option. Select the plane where the H-Field will be applied as shown in Fig.8. Thus dual band microstrip antenna is simulated using AN-SOF software and the corresponding results are observed.

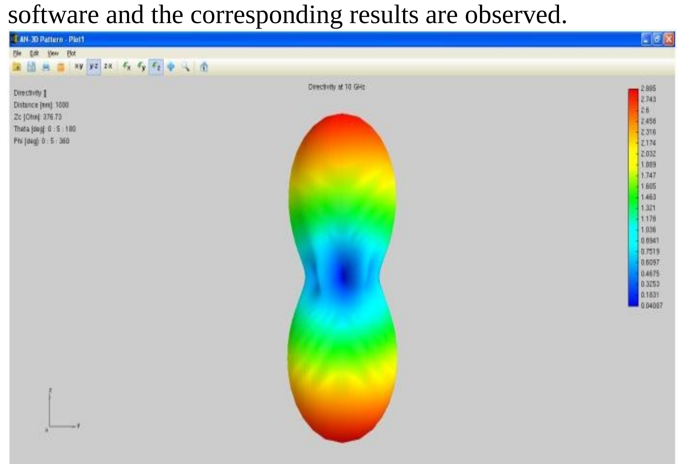

Fig.7. Directivity of dual band microstrip antenna.

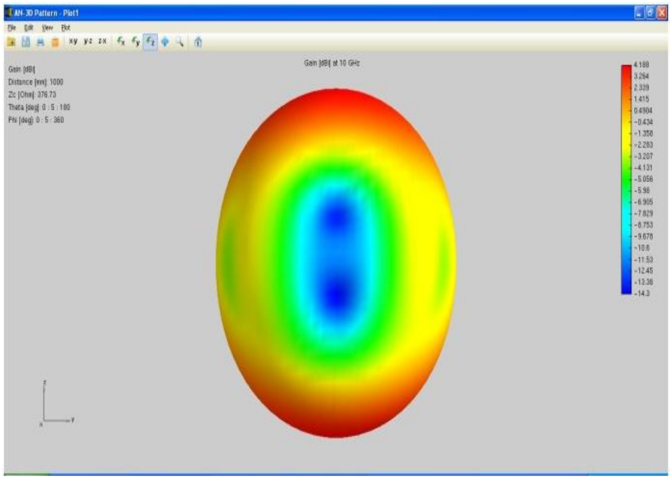

Fig.8. Gain in dB of dual band microstrip antenna.

V. CONCLUSION

Among many EM tools, AN-SOF emerges as a potential software to solve antenna design problems. Two antennas namely Yagi Uda antenna and Dual Band Microstrip antenna are successfully designed. Their analysis is performed using reports. The designed Yagi Uda antenna operates at 3 GHz frequency band for its radius 5mm. The designed Dual band microstrip antenna operates at 10 GHz frequency band for its radius 1.4232mm.

VI. ACKNOWLEDGEMENT

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